Ph.D. Research Plan

On

Mitigating QOS In Mobile Ad-Hoc Network

Submitted by

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1. Introduction

Mobile Ad-Hoc Networks (MANET) is formed by mobile nodes that are able to communicate with each other using a wireless medium without having any preexisting infrastructure. Mobility has a major impact on the performance of MANET, as it results in frequent change in network topology. These limitations includes different span which includes security, fault tolerance and reliability. Our objective is to minimize these limitations which can affect QoS, by proposing new methods and models for MANET. And to carry out study on the result produced by these developed scheme (methods/models).

1.1 Mobile Ad hoc Network (MANET) Preface

Definition

It is an autonomous collection of mobile nodes, with networks built on the fly for a specific purpose (i.e., emergency situations, rescue operations, battlefield situations, etc.), that talk to each other over bandwidth constrained wireless links. The Internet Engineering Task Force (IETF)[1], the body responsible for guiding the evolution of the Internet, provides the definition as given below [2]:

A mobile ad hoc network (MANET) is an autonomous system of mobile routers (and associated hosts) connected by wireless links. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a stand-alone fashion, or may be connected.

Or in simple terms we can say that A MANET is an Independent Basic Service Set (IBSS). Only pairs of nodes that lie within each other's transmission radius can communicate directly. **Salient Features of MANET**

No Direct Link If there is no direct link between the source and destination then path is dynamically discovered using some routing protocols. This path will include one or more hops to reach the destination data packets are transferred using these multiple hops.

Mobile nodes Nodes are free to move arbitrarily; thus, the network topology-may change randomly and rapidly at unpredictable times. Due to this dynamic route has to be discovered.

No fixed infrastructure It does not require any centralize router all host can work as a router. So it does not require any back bone. That is why it is known as infrastructure less network.

Resource Nodes in a MANET may rely on batteries for their energy, For these nodes, the most important system design criteria for optimization may be that of power conservation.

Network Bandwidth As MANET is working in wireless environment so bandwidth is limited and also different mobile nodes may have different link capacity

Mobility problem can be easily understand with the help of a scenario that is shown in the following figure 1.1a 'S' wants to communicate with nodes 'D'. They are communicate using '1' intermediates nodes

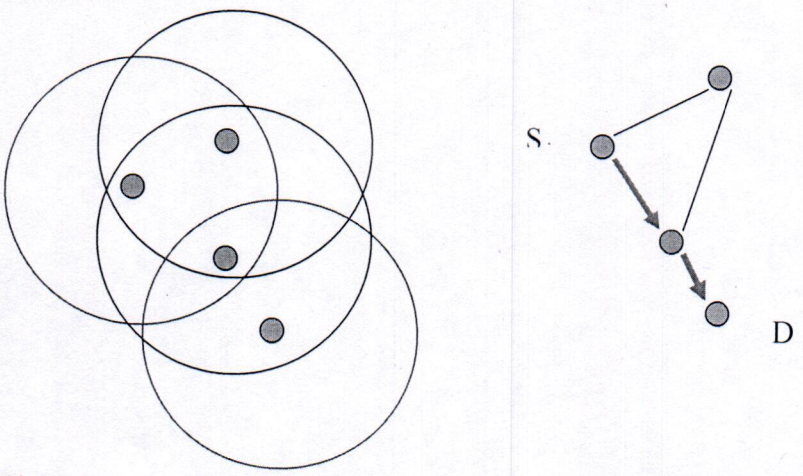


Figure 1.1a Routing between 'S' to 'D' at time t_1

As nodes are mobile so it may be the case that the path earlier may not exist.

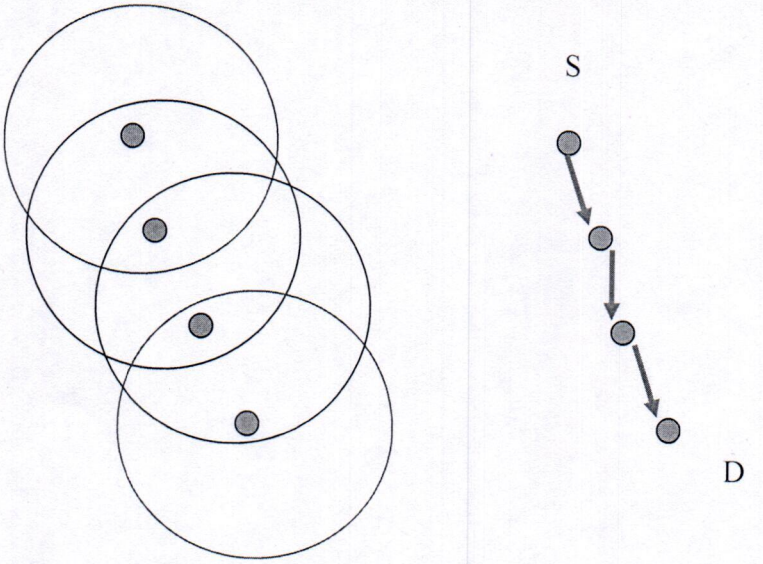


Figure: 1.1b Showing the new path at time t_2

Hence it can be seen that in figure 1.1a only one intermediate hops, but in the next figure 1.1b two inter hops are required to transfer the data. The new path must be dynamically discovered. This is what the complexity of MANET.

Why to use MANET

Following are the major points which make MANET useful:
Setting up of fixed access points and backbone infrastructure is not always viable

No fixed Access point and backbone infrastructure

Easy to deploy

Useful when infrastructure is not present, destroyed or impractical

No rely on central control

Applications of MANET

In addition, self-organizing mobile networks can be operated as robust, inexpensive alternatives or enhancements to cell-based mobile network infrastructures [3]. Its application scope can be classified as:

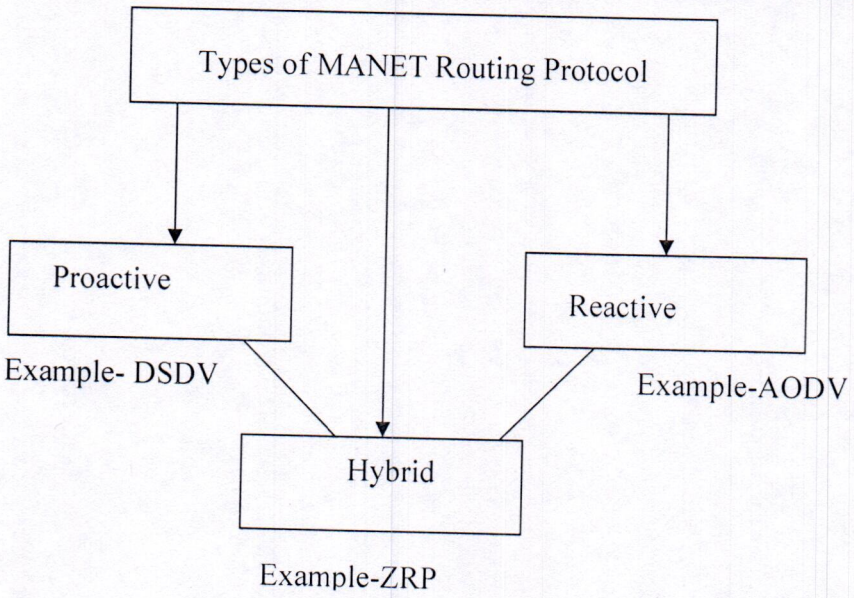
Military environments: To equip soldiers with devices in enemy environments so they can communicate with each other for tactical operations. Examples are soldiers equipped with Personal Digital Assistants (PDAs), tanks, planes and warships.

Emergency operations: To setup communication in life-threatening situations like search and rescue, emergency situations like policing and fire fighting and disaster recovery.

Civilians environments: Used for accessing and sharing data with other potential users; e.g., distribution of presentations, exchange of information, etc. within a taxi cab network or meeting rooms or sports stadiums and small aircrafts.

1.2MANET routing Models

As MANET came into picture after fixed network, so lots of work are still needed to do, so that some standard protocols can be made that can overcome all the limitations of mobile nodes. The routing protocols in MANET are divided into three major categories.



1.2.1 Proactive (table driven) Routing Protocols

It maintains consistent, up-to-date routing information from each node to every other node in the network. Each node is required to maintain one or more tables at each node. The amount of information propagated each time is typically proportional to the scale of MANET. DSDV[4] (Destination Sequenced Distance Vector) is an example of such routing, DSDV is just an advancement of Bellman-Ford routing algorithm[5] as it removes loops in a network. It may pay costs to construct routes even if the hosts do not have such need, thus wasting the limited wireless bandwidth. Many other routing protocols have been proposed which only create paths when it is demanded.

DSDV is enhanced with the freedom of loop and differentiation of stale routes from new ones by sequence numbers. Each mobile host maintains a sequence number by monotonically increasing it each time the host sends an update message to its neighbors. A node will replace only when the destination sequence number is less than the new one, or two routes may have the same sequence number but one has lower metric.

1.2.2 On Demand Routing Protocol

Many reactive protocols have been proposed on such on-demand philosophy, such as dynamic source routing (DSR)[6], ad hoc on-demand distance vector routing(AODV)[7], and a hybrid of proactive and reactive approach, called as Zone Routing Protocol(ZRP)[8].

Route Discovery. DSR[6] is derived from the concept of source routing. If a source node needs a route to the destination node, it broadcast a RREQ packet to all its neighbors. On receiving this request, two things may happen. If the node does not know route to the destination, it appends own address to the packet and propagates the RREQ to its neighbors. Thus path leading to the destination can be traced by RREQ packets. When the destination receives a RREQ it returns a reply by using RREP packet, which contains the route copied from the RREQ. The source node on receiving the RREP, will place the routs in its cache. In the second case, an intermediate node is also allowed to return a RREP if it already knows a path to destination.

AODV[7] is based on the DSDV protocol. It improve DSDV by using on-demand philosophy to reduce the route maintenance cost, so host that are not on active path are not required to change information. A host broadcast RREQ packet to its neighbors. If a neighbor is an intermediate node and does not have any route to the destination, it broadcast the RREQ packet further. Also, if neighbor has a route to the destination but the sequence number is less then the sequence number registered in RREQ packet, the neighbor broadcast it further. If a neighbor is the destination host or an intermediate node with larger sequence number than RREP is sent back to the source.

1.2.3 Data Forwarding

The data forwarding part specifies how data packets are forwarded. Two ways are possible: source routing and next-hop routing. In *source routing*, the whole path is specified in each packet header, and an intermediate node will not check any table for packet transmission. The DSR falls in this category.

On the contrary, in *next hop routing*, only the destination node is specified in the packet header, each intermediate host must keep routing table to determine to which next host packet must be transferred. The AODV, AQR and proposed *PBRS* fall under this category.

Former one is better because, routing information is kept in intermediate nodes. Since routing table may change dynamically, data packets belonging to the same session do not necessary follow the same path. This allows some level of fault tolerance. So this approach is more resilient to host mobility because we are allowed to fix some broken links locally without this being noticed by the source node, whereas in source routing, whenever an intermediate node roam away, we must go back to the source to discover a new route.

1.2.4 Route Maintenance

In most protocol, on knowing that a route is broken, an intermediate host with undelivered data packets can issue a RERR(route error) packet back to the source. On such notification, the source host invokes another route discovery to construct a new path. On finding the broken route, it is not always necessary to construct a fully new route from the source. This could be too costly. In most cases a route may become invalid due to a broken link. While other part of path is still intact. In such cases a local route recovery can be used [9]. It says we only fix the broken link using a partial route local to where the link is broken. When a host finds that its next link is missing, a local route discovery with a limited hop count (typically not exceeding 4) will be issued so to avoid global flooding.

2. Research Areas and QoS In MANET

2.1Research Areas in MANET

Some of them are as follows:

Routing-Different routing protocol are already developed that includes AODV, DSR, DSDV etc. All have some limitations and advantages over other. Still there is need to develop more reliable protocols.

QoS- The advances in wireless communications and growth of real-time applications have necessitated the development of wireless networks that support a high quality of service (QoS). The performance of a single channel Adhoc network depends largely on the medium access control (MAC) protocol. A number of MAC protocols have been proposed in recent years, each of which has focused on improving and optimizing a few selected QoS issues.

Power-aware routing-The Nodes are mobile in MANET, due to which they have small battery life time. So methods are required to use these batteries in optimized way, which open a new research ground for MANET

Security-MANETs are much more vulnerable to attack than wired network. This is mainly because of the Open Medium, Lack of Centralized Monitoring and topology less infrastructure.

2.2 Quality of Service (QoS) in MANET

The QoS specification and management are required to support multimedia applications (such as video and audio transmissions). In multimedia, this might include picture quality, image quality, delay and speed of response. From a technical point of view, QoS characteristics may include timeliness (e.g. delay or response time), bandwidth (e.g. bandwidth required or available), reliability. Hence its parameters can be summarized as:

Bandwidth: This defines the data rate for an application's traffic.

Latency: The delays between packets send time and packet arrival time

Jitter: The variation in latency.

Loss: The percentage of packet loss.

Different applications have different QoS requirements. Figure 2.2 show that video has the highest bandwidth requirements; whereas filler traffic, such as email, has the lowest bandwidth requirements. Likewise, voice and video traffic requires the lowest latency, whereas email can tolerate high latencies.

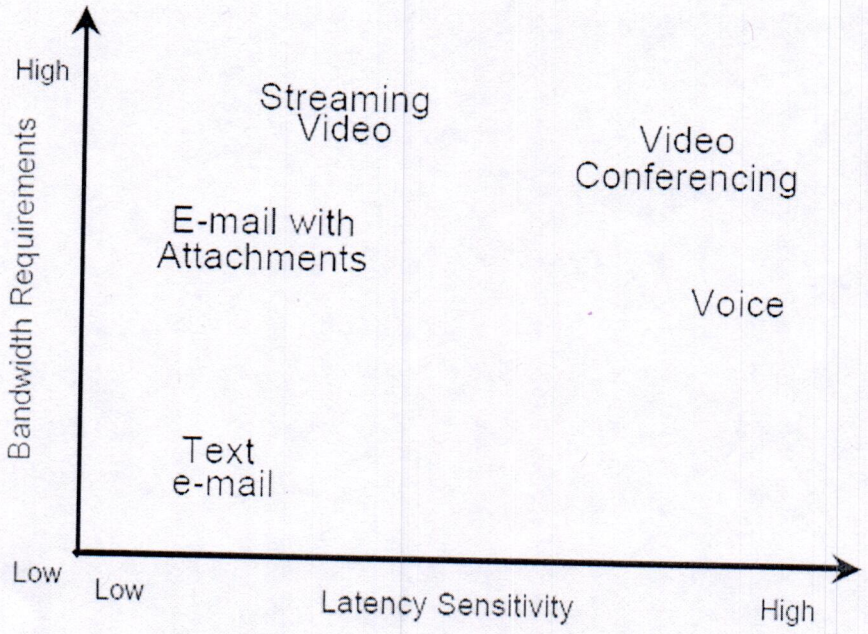


Fig 2.2 Tradeoff of Latency with bandwidth of different applications

3 Limitations for implementing QoS in MANET

Implementing QoS in MANETs is difficult due to its broadcast and dynamic nature. First, unlike wired networks, a wireless link's bandwidth may be affected by the transmission of adjacent links. Second, unlike cellular networks, which only need to guarantee quality for one hop, in MANET we must guarantees the quality for the multiple hops in the path. Third, mobile host may leave or join at any location and time, existing links may get disappear and new links may be formed as host move.

These can be highlighted as follows:

Limitations of the Wireless Network

- packet loss due to transmission errors
- variable capacity links
- frequent disconnections/partitions
- limited communication bandwidth
- Broadcast nature of the communications
- Limitations Imposed by Mobility
- dynamically changing topologies/routes
- lack of mobility awareness by system/applications

Limitations of the Mobile Computer

- short battery lifetime
- limited capacities

4.Related work And Literature Survey

The existing QoS models[10][11]can be classified into two different types-the Integrated Services (IntServ)[12]which provides explicit end-to-end reservations and the Differentiated Services (DiffServ) architecture offers hop-by-hop differentiated treatment of packets.

IntServ use Resource Reservation Protocol (RSVP)[13] which was designed as the primary signaling protocol to setup and maintain the virtual connection. RSVP is also used to propagate the attributes of the data flow and to request resources along the path.

While IntServ provides per-flow guarantees, Differentiated Services (DiffServ) follows the philosophy of mapping multiple flows into a few service levels. DiffServ[14] overcome the difficulty of implementing and deploying IntServ and RSVP. In Diffserv At the boundary of the network, traffic entering a network is classified, conditioned and assigned to different behavior aggregates by marking a special DS (Differentiated Services) field in the IP packet header (TOS field in IPv4 or CLASS field in IPv6). Within the core of the network, packets are forwarded according to the per-hop behavior (PHB) associated with the DSCP (Differentiated Service Code Point). This eliminates the need to keep any flow state information elsewhere in the network.

The drawback of DiffServ is that traffic classification and conditioning only has to be done at the boundary nodes. This makes quality of service provisioning much easier in the core of the network.

INSIGNIA is a signaling protocol designed explicitly for MANETs. It supports fast flow reservation, restoration and adaptation algorithms that are specifically designed to deliver adaptive real-time service. INSIGNIA implements an in-band approach by encapsulating some control signals in the IP option of every data packet, which is now called INSIGNIA option. Furthermore flow state information is kept in every node of a particular path. The flow state information is periodically refreshed by the received signaling information.

The basic operation of the signaling system is described with respect to INSIGNIA IP option. The major drawback if INSIGNIA though is that flows state information may face scalability problem. Moreover INSIGNIA design basically enables the existence of only two class of services real time (RT) and best effort (BF).

In CEDAR [15] QoS is maintained by extracting core graph, which is an overhead to estimate and it will be more complicated if number of nodes got increased. In CASMA [16] estimates the end-to-end path life time and does not provide any procedure for preemption. AQR [17]

proposed bandwidth reservation and also use delay and cost as its parameter to provide routing. It does only consider two kinds of flow best-effort and real-time flow, but obviously real-time applications can be classified into many priorities basis. EERV[18] proposed reservation on end to end basis but does not provide precedence among flows. M-AODV[19] works as a variant of AODV with added QoS feature but priority among flows with preemption is not considered. The proposed PBRS (Preemption And Bandwidth Reservation Scheme) is a major advancement on AODV by considering priorities and backlog among flows.

5. Objective of Research

The research is focused to present methods to implement QoS in MANET fairly. The method should provide a suitable admission controller and can organize flows according to the priority. It will also perform flow preemption if the remaining bandwidth is less than the required one.
The research will be oriented on probability estimation that is based on:

a) Priority difference
b) Oldness of flow

It will consider priorities among the different real time application for reserving bandwidth. Normally traffic is divided into two kind's real-time and best effort. In addition to priority it also takes account on the priority difference and the flow oldness (backlog). Proposed procedure (PBRS) is used in PBRS for decide a flow request should be granted or not.

The method should be perform in a manner such that to provide preemption with fairness, A process based on backlog and priorities of flows, Minimizing the preemption disruption to existing connections and Providing best QoS to the high priority flows. Future work will also include the detection and prevention of flooding effect on QoS.

6. Research Methodology

Due to various limitations as discussed above we will explore the possibility to provide some enhancement on the presents proposed methods that can best suited for MANET.

For proper utilization of bandwidth , we will explore new method that can use low priority flow to enrich the bandwidth for other flow that have stringent QOS requirement, so that high priorities flows will not starve for longer time.

These proposed tools and methods will be analyzed by using ns2 simulator and/or if required by developing application in Java platform.

Methodology will include evaluation the proposed methods/protocol on different parameters like:

- Packet size
- Throughput
- Average End to End Delay
- Constant Bit Rate(CBR)
- Simulation Time
- Scaling factor etc.

7. Proposed Plan

7.1 Problem Area

Quality of Service in MANETs became an area of great interest. Besides the problems that exist for QoS in wire-based networks, MANETS impose new constraints. This is due the dynamic behavior and the limited resources of such networks. So QoS is more difficult to implement in MANET. The problem is "*Maintaining QoS for real time data is difficult in MANET as there are constraints imposed due to wireless link, mobile nodes and limited capacity of mobile devices. Providing more quality (better path) to high precedence flow and to eliminate the effect of intruders on QoS performance*".

7.2 Solution Proposed

The gist of proposed Precedence Based Preemption and Bandwidth Reservation Scheme (PBRS) in MANET is given as follows:

- PBRS will take the decision for preempting a flow $flow_i$ on the basis of its priority p_i and oldness of $flow_i$.
- It is being assumed here that an older flow have high amount of backlog in queues, so if any older flow is preempted then there will be more data loss.
- Hence the flow having fewer backlogs is a better candidate to preempt as discussed in.
- The preemption process is delayed till RREP message is received at a link.
- The more the priority difference more will chances of preemption
- Probability based decision to preempt a process based on priority difference and flow oldness

7.3 Proposed PBRS

(Sourabh Singh Verma, Saroj Kr Lanka, R.B.Patel ,"Precedence Based Preemption and Bandwidth Reservation Scheme in MANET", IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 6, No 2, November 2012 ISSN (Online): 1694-0814)

The following terms are used PBRS procedure

Max ΔT_{P_i} =Threshold (max) time after which the link for

flow having P_i priority cannot be preempted.

ΔT_{P_i} =is the current existing time of flow 'i' in link.

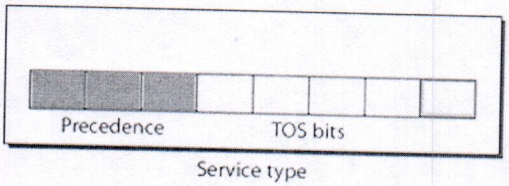
Fp(ΔP_{fi} , ΔT_{p_j}) is the probability function on priority difference and the oldness of a flow 'i' in link.

ΔP_{fi} =difference between priority of requested 'f' flow with the flow 'i'.

If difference in priorities ΔP_{ij} are less than probability for preemption will be less and vice versa. So that preemption among the flows where their priority is likely same are not preempted by newly arrived flow.

Procedure background:

i. As it will use the three precedence bits of IP datagram, the total number of priorities are eight.



Service type

ii. The threshold difference is considered to be 3.that is, chances of preemption of a flow with priority difference less than 3 are less and if difference is more than 3 then probability is considered to be '1'.

iii. The older links are considered having more backlogs in queues, so preempting them will definitely cost more. As, it will have more packet loss and more delay. Therefore flows with low backlogs are candidate for the preemption.

iv. The oldness of a link is divided into four categories.

1. Just started(y value assigned 4)
2. Growing stage1(y value assigned 3)
3. Growing stage 2(y value assigned 2)
4. Grown stage(at this level probability of preemption will be '0' & y value assigned 1)

The probability to preempt the flow will decrease with the oldness of the flow (1 to 4) . 'y' value used and explained at section VI.

v. The difference in the priority is also taken into account because if we preempt flow 'i' with 'j' having marginal difference. Than we have to reroute the flow 'i' by another route and it will be a overhead and packet of flow 'i' will be lost in backlogs. So, it will be better to route 'j' from another path, may be another path have longer delays due to more number of hops

PBRS Procedure

Consider currently request flow 'f' is competing for the link 'k'

The procedure can be divided into three parts

a) Admission controller

Case1 (Breqj<=Bavailk)

Then 'k' can be assign to flow 'f' and metric is updated.

Case2 (Breqf>Bavilk) then do the following

Integer ,i=0,

size=size of flow table having priority <Pj

Array Pd[size],Bd[size]

Where Pd represent difference between priority of flows with flow 'f'. Bd is array that represents the bandwidth difference between the flows and require flow 'f'

b) Dropping RREQ

RREQ can be droped in any one case

i)We can drop RREQ if there is no such flow whose priority is less then requesting flow 'f' i.e size=0

ii) Can be dropped when the Breqj is more than the bandwidth occupied by each flow 'i' for(each i) Breqf>Bocci

c).Calling Preemption

If RREQ is not dropped due to above reason, then preemption process can be called. Preemption process will be called for such a flow 'i' whose priority difference is highest

with the flow 'f' and bandwidth required by flow f is lesser than by flow 'i'.

Preemption Process(Pd[i],flow i ,k)

If success is returned then update the tables else drop RREQ packet.

Preemption Process(diffPif, flow to be preempted ,link)

If (ΔP_{fi} =Pf-Pi>=Max ΔP and ΔT_{p_j} ==0) then

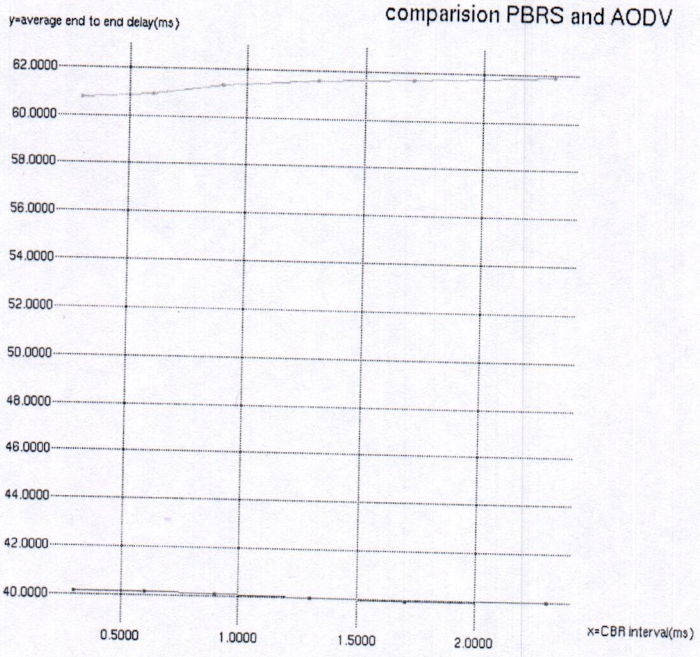
Probability to preempt flow 'i' from link k will be 1. Hence success is returned to process procedure.

Else probability function is evaluated which can be given as follows:

$Fp(\Delta P_{fi}, \Delta T_{p_j}) = \{fd(\Delta P_{fi}) \times ft(\Delta T_{p_j})\} = p$

$$fd(X) = \begin{cases} x/8 = 1 \text{ for } x = 4,5,6,7 \\ x/8 \quad \text{for else} \end{cases}$$

Performance Comparison of PBRS with AODV



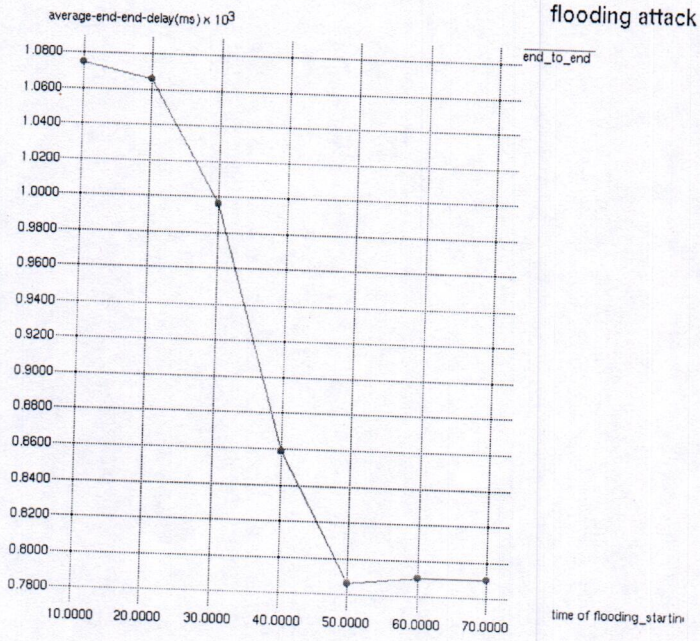
End to End Delay and CBR interval is chosen as performance matrices. The result shows that PBRS is better than AODV.As in AODV the range of end to end delay is between 60 to 62 ms while in PBRS range is near to 40 ms. As in PBRS high priority data goes from shorter path by preempting low priority flow. While low priority flow can be moved to longer path, so a balanced is obviously made with both kinds of flows.

7.4 Future Plan

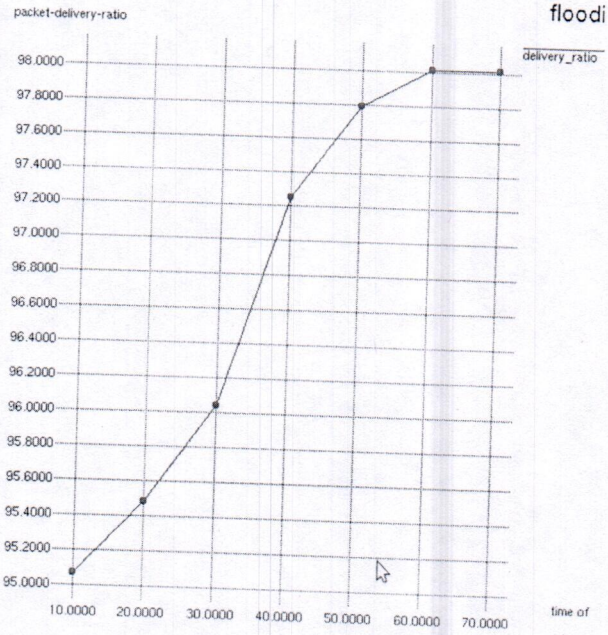
In future PBRS will be compared with other routing protocols like DSDV, DSR, M-AODV, AQR on different parameters like packet size, scaling factor etc.

To purpose solution and evaluate effect of Intrusion on QoS parameters.Some of these effect are already evaluated as given below:

Average End-End Delay



Packet-Delivery Ratio



So from above comparisons we can evaluate that end-to-end packet delay is increased if flooding started early. Similarly Packet-Delivery ration is decreased with the increase of flooding duration.

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